8

APPLICATION OF MATERIALS DATABASE (MAT. DB.) TO MATERIALS EDUCATION

Ping Liu

and

Tommy L. Waskom

School of Technology
Eastern Illinois University
Charleston, Illinois 61920

Telephone 217-581-6267

Application of Materials Database (MAT. DB.) to Materials Education

Ping Liu and Tommy L. Waskom
School of Technology
Eastern Illinois University
Charleston, IL 61920

KEY WORDS: material properties, strength, ductility, material data base, environment and working conditions.

PREREQUISITE KNOWLEDGE: The student should understand the fundamentals of materials behavior such as tensile strength, percent elongation, area reduction, manufacturability and formability. Some understanding of change in material behavior with different environments and loading conditions is expected. Knowledge of the basic application of a microcomputer and DOS commands are essential.

OBJECTIVES: To use the materials database MAT. DB. to search for useful data on materials behavior related to specific applications. With the materials database, design analysis, materials selection and manufacturing of products can be more efficient.

EQUIPMENT AND SUPPLIES:

1. IBM compatible 286 or higher microcomputer.
    a. 640 K RAM
    b. At least 15 M free hard disk
    c. Graphics card of CGA, Hercules, EGA, and VGA
    d. 4.25" or 3.5" floppy disk drive
    d. DOS 3.0 or higher.
2. MAT. DB and database files from ASM International.
3. Printer is optional for output.

INTRODUCTION:

Finding the right material for the job is an important aspect of engineering. Sometimes the choice is as fundamental as selecting between steel and aluminum. Other times, the choice may be between different compositions in an alloy. Discovering and compiling materials data is a demanding task, but it leads to accurate models for analysis and successful materials application.

Mat. DB is a database management system designed for maintaining information on the properties and processing of engineered materials, including metals, plastics, composites and ceramics. It was developed by the Center for Materials Data of American Society for Metals (ASM) International. The ASM Center for Materials Data collects and reviews material property data for publication in books, reports, and electronic database. Mat. DB was developed to aid the data management and material applications.

Mat. DB can provide the following functions to manage database for materials:

1. View information on specific material:

The material data are organized in material records, which include material

designations, specifications, composition, product forms, classes, ranking, properties, graphs and notes. Once entering the database, the user can navigate among the nine categories of information for a specific material.

2. Searching:

One of the most powerful features of Mat. DB is its ability to search through megabytes of information to locate needed material data. The user begins a search session by creating a "folder", which contains all related results. The searched folder can be viewed in the same manner as above.

3. Editing:

Users can build their own database with the tools provided by Mat. DB. Sophisticated databases can be established to suit various applications for users.

4. Reports:

Mat. DB is capable of viewing and printing the results of a search in formats that help analyze search results.

PROCEDURE:

1. Start the Mat. DB and load the desired database file for the material of interest. A main manual will be prompted for each database file.

2. View data for a specific material:

After choosing "VIEW FOLDER" from the main manual, a material record manual will be shown on the screen. Mat. DB's basic building block is the *Material Record*, the file in which information on materials is organized. A separate record is devoted to each materials designation, e.g. AISI 1020, Ti-6Al-4V, etc. These records are then stored in Mat. DB databases. Each record can contain the following information for a given material:

Designation: The designations screen contains necessary information to identify the material and source of the data. It includes *Accession Number* (an identifying number unique to a material record), *UNS Number* (a cross-referencing number standardized by American Society for Testing and Materials (ASTM) and Society of Automotive Engineers (SAE)), *Material Group*, *Designation*, *Common Name*, *Manufacturer*, *Country* and *User*.

Specifications: Each material can be cross-referenced to a maximum of 50 alternate specifications. Each specification can be annotated with a short note.

Composition: Minimum and maximum percentages can be maintained for up to 20 elements. Additional comments on compositions can also be stored for display along with the element percentages.

Product Forms: The user may index the material by up to 50 different product forms.

Classes: The user may index each material condition by up to 50 application classes such as heat resistant, high strength, etc.

Ranking: Each material condition can be ranked for processing characteristics such as formability, weldability, machinability, hardenability, processing cost, and availability. The user can define up to 6 ranking categories.

Properties: Properties can be reported for up to 20 different conditions per material. For each condition up to 100 properties can be reported at as many as 20 temperatures. The properties are displayed on a screen that looks like a spreadsheet.

Graphs: Up to 20 graphs can be maintained and displayed for each material. Graphs can also be saved to a DOS file or printed directly to a laser or dot matrix printer.

Notes: Mat. DB can maintain up to 200 lines of comments for each material. The Notes section offers many standard word-processing features, making it extremely easy to add new comments to a record or edit existing comments.

3. Search information with "SIFT FOLDER" feature of Mat. DB.

Material information can be searched according to various combinations of material data on designation, specifications, composition, forms, classes, rankings, properties and so on. For example, in the folder of STARTER.DB (database supplied with Mat. DB), "sift folder" with the following conditions

CLASSES = CORROSION RESISTANT and
FORMS = BARS

results in the following three materials

316	STAINLESS STEEL
410	STAINLESS STEEL and
A3003	WROUGHT ALUMINUM.

All the material data on these three corrosion resistant bars can be found using the "VIEW FOLDER".

4. Build your own database with "editing" feature of Mat. DB.

If the database was opened in the *read-write* mode, a new material record can be created by moving the highlight to "new" at the bottom of the *List Screen* and pressing *enter*. This will open an empty material record.

The new material record will begin with "DESIGNATION" and data will be entered in the edit boxes. When finished, press the F10 function key and the editing will be saved.

5. Output the results:

The results can be printed with a dot matrix printer.

SAMPLE DATA SHEETS:

The following are two examples for the property data of AISI 4140 steel and high density polyethylene, respectively.

A. AISI 4140 Steel

Database: STARTER.DB
Folders: Metal Alloys (11)
View Folder: 4140 G41400 Alloy Steel

1. Designation

Accession Number	281189015
UNS Number	G41400
Material Group	Alloy Steel
Designation	AISI 4140
Common Name	4140
Manufacturer	
Country	USA
User	ASM

2. Specifications

Organization	Specification
AMS	6381 (*Aerospace Material Specification)
AMS	6382
AMS	6390
AMS	6395
ASTM	A322
ASTM	A331
ASTM	A505
ASTM	A519
ASTM	A547
ASTM	A646
MIL	S-16974
SAE	J404
SAE	J412
SAE	J770
DIN	1.7225

3. Composition

Element	Min.%	Max. %
C	.38	.43
Cr	.8	1.1
Mn	.75	1.
Mo	.15	.25
P	.	.035
S	.	.04
Si	.15	.3

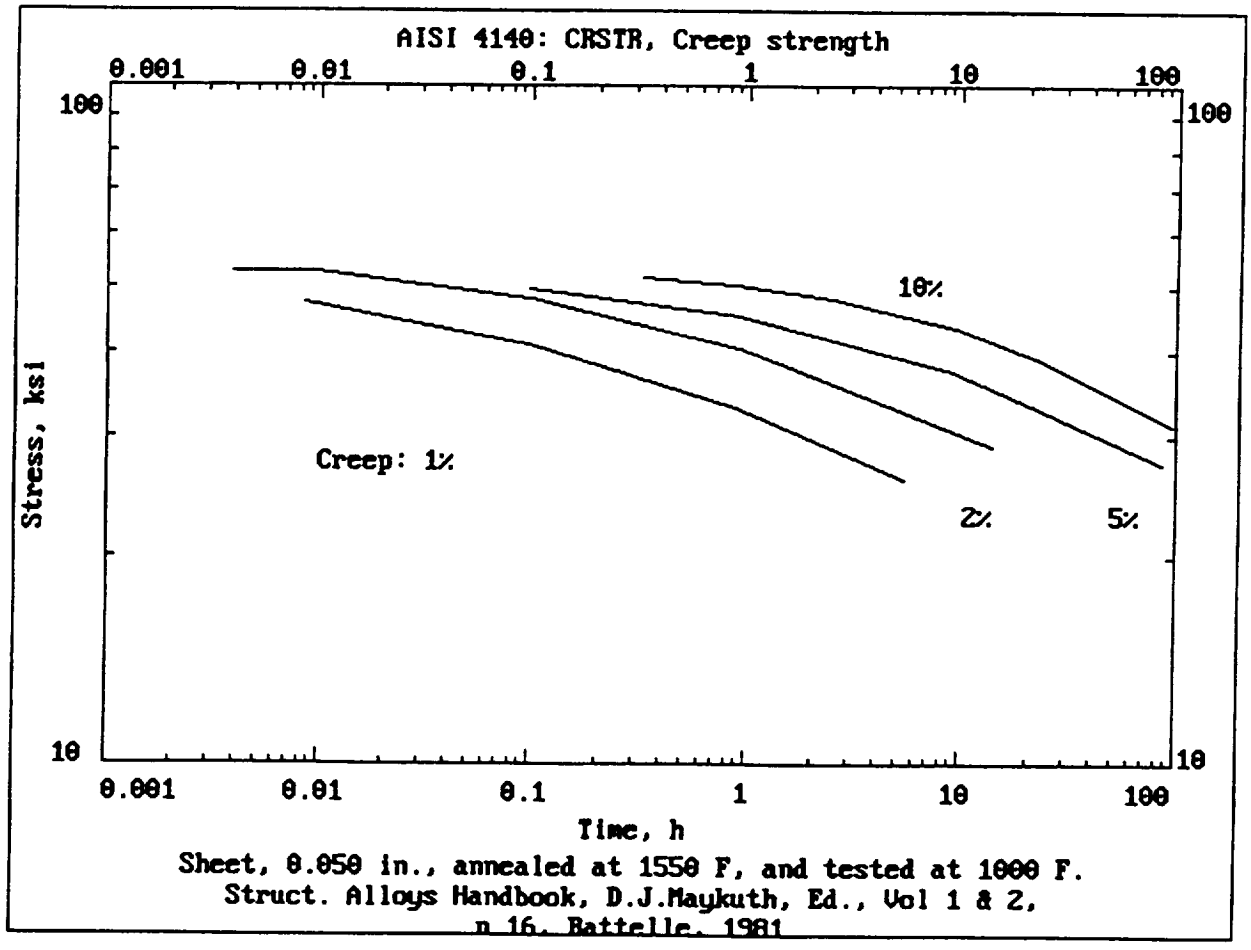
4. Notes
High-hardenability, medium-carbon steels; popular grades
DESCRIPTION: Grades 4140, 4140H, 4142 and 4142H are combined for discussion purpose because they are so similar in compositions and characteristics. Actually, they are so close that the composition could be either 4140 or 4142.
...

5. Properties

4140 Typical Properties

	100 ^{o}C	200 ^{o}C	400 ^{o}C
ElResis n{o}*m	262.	326.	475.
ThCoefExp {u}m/m*K	12.2	12.6	13.7
ThConduct W/m*K	42.6	42.2	37.7
ThSpcHeat J/kg*K	.	473.	519.

6. Graphs: One example is shown below.



B. High Density Polyethylene (HDPE)

Database: THERPLAS.DB
Folders: Polyethylene (A-M) (63)
View Folder: Marlex HXM 50100

1. Designation

Accession Number	81789333
Code Number	190100
Material Group	Polyolefin
Designation	Polyethylene
Common Name	Marlex HXM 50100
Manufacturer	Philips Chemical Co.
Country	USA
User	Engineering Thermoplastic

2. Notes
High-density polyethylene, use with food and drugs.
Uses: Large formed parts, cattle feeders, pallets, boats

FOOTNOTES
A Condition 190/2.16
B Type IV specimen, 2 per min.

3. Process: Thermoforming

4. Properties

	Typical Properties
	23 ^{o}C
Density, kg/m^{3}	950
FlexModul, GPA	2.08
StrElgYld, %	600
TenYldSt, MPa	26

5. Features:
Impact resistance
Food/drug use

6. Rankings
Chemical Resist.
Creep Resist.
Fatigue Resist.
Heat Resist.
Processability
Cost

INSTRUCTOR NOTES:

1. It is always a good idea for students to start with "Read-Only" mode for materials database folder. In the "Read-Only" mode, no change in any material record will be saved. This will prevent any useful information from being lost.

2. When searching materials with "SIFT FOLDER", students need to make sure to use "NEW" in the folder list. Otherwise, the existing folders will be replaced by the new folder. Some information could be lost.

3. Basic knowledge of DOS for microcomputer will be essential to the operation.

REFERENCES:

1. Puttre, Michael: Materials Data Bases are Key to Design Analysis, *Mechanical Engineering*, vol. 115 (5), 1993, pp 69-71.

2. ASM International, Materials Properties Database System: Mat. DB, ASM/Center for Materials Data, Materials Park, OH 44073, 1992.

SOURCES OF SUPPLIES: This is basically a computer software project. Microcomputers are readily available. However, the software is relatively expensive. The Mat. DB costs approximately $556-695, and material database files cost from $295.20 to 526 for each major category of materials. But, the software and database files can be purchased separately, which makes the cost planning a little easier.

ACKNOWLEDGMENT: Financial support for this project from the Council for Faculty Research (CFR) at Eastern Illinois University is greatly appreciated.